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Cost-Sharing to Help Clean Our Waterways

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COVER: A recent study by National Bureau of Standards' economists examined the effectiveness and efficiency of Federal cost-sharing in projects aimed at abating wastewater pollution. For their conclusions and recommendations, see story on page 267.

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Betsy Ancker-Johnson
Assistant Secretary
for Science and Technology

NATIONAL BUREAU OF STANDARDS
Richard W. Roberts, Director

Prepared by the NBS Office of
Information Activities
Washington, D.C. 20234
William E. Small, Chief

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Cost-Sharing to Help Clean Our Waterways

WATER pollution is a serious problem but no one is sure just how to solve it. Large inflows of inadequately treated sewage continue to pollute our waterways, while the costs of purifying wastewater continue to rise. How can the difficult and expensive fight against pollution be financed?

To help clean the Nation's water, Congress mapped out a cost-sharing program in the Federal Water Pollution Control Act Amendments of 1972. The principal cost-sharing program described by the 1972 Act was the Environmental Protection Agency's Construction Grant Program. It provides local communities with partial Federal funding for projects to abate wastewater pollution.

To "assist and serve as an incentive in construction of publicly owned treatment works" is the Construction Grant Program's objective. By sharing the costs of constructing abatement facilities with cities, towns, counties and other municipal jurisdictions, the Federal Government hopes to achieve clean water nationwide.

During 1974, EPA asked the National Bureau of Standards to evaluate the Construction Grant Program in terms of efficiency and equity. NBS economists Dr. Harold E. Marshall and Rosalie T. Ruegg consequently produced a paper which examines the cost-sharing program. "What we found," said co-author Ruegg, "is that cost-sharing is not as efficient nor as equitable as it could be."

Choosing the Best Method

When a municipality decides to clean up its wastewater, a rational approach would be to choose the method that would provide a given level of abatement at least cost for that municipality.

The municipality's choice, however, may not be the least costly choice for the Nation, according to the authors' research. Under current cost-sharing rules, cities or towns may be encouraged to choose techniques that cost local taxpayers the least, but which are not least costly to the Nation. Furthermore, current rules may encourage communities to build oversized facilities.

A major cause of these inefficiencies, according to Marshall and Ruegg, is that the Construction Grant Program provides different levels of Federal funding for different kinds of abatement techniques and costs.

Specifically, the Federal Government picks up 75 percent of the tab for capital cost and cost of land that

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is integral to the treatment process (generally referred to as construction costs). However, Federal funding does not cover operation and maintenance costs or other land costs.

With this type of cost-sharing scheme, communities may reduce their own costs by choosing construction-intensive anti-pollution techniques. For example, a local government may elect to build an expensive sewage treatment plant because EPA pays 75 percent of its construction cost, even if the plant's total price tag—the municipality's cost share plus the Federal Government's cost share—exceeds that of other, equally effective techniques.

Alternative Anti-Pollution Techniques

"There are a number of technically viable alternatives," Ruegg noted, "which alone or in combination may offer an improvement in cost effectiveness over conventional treatment."

The wide range of alternative anti-pollution techniques includes reducing water use, enlarging and rehabilitating sewer collection systems, pretreating wastewater in the sewer system and separating wastewater sewers from storm sewers.

In addition, conventional waste treatment plants can be aided or replaced by community septic tanks, land treatment of wastes, aeration of receiving waters and even by raw sewage lagoons. When operating properly, septic tanks and land treatment both allow wastewater to seep through the ground, entering the ground water supply as naturally cleaned water. Raw sewage lagoons similarly allow natural processes to clean wastewater; the interaction of sunlight, oxygen, bacteria and algae decomposes waste and restores the water's purity. Artificially injecting air or molecular oxygen into waterways increases the water's quality and its capacity to assimilate wastes.

All of these or other alternative techniques, which range from teaching the public water-saving practices to irrigating land with partially treated wastewater, differ in their eligibility for Federal funds under the Construction Grant Program. Any technique which requires a large expenditure on operation and maintenance rather than on capital will receive relatively little assistance from the Construction Grant Program.

To correct these biases and their resulting inefficiencies, Ruegg and Marshall recommend that the Federal Government share construction costs and operation and maintenance costs in the same proportion for all pollution abatement techniques at a given location.

A Question of Scale

If a municipality decides to build a waste treatment facility, the next question is: How big? Choice of scale depends on cost-benefit criteria; economic theory suggests a rational decision maker will develop his facility to the point where marginal cost equals marginal benefit. This simply means the decision maker tries to get the most out of each dollar spent.

Cost sharing has incentive effects on municipalities that can result in their picking abatement projects that are too large, too small or just right in size from the standpoint of national efficiency. Consider an example where cost sharing would provide an incentive for overbuilding.

For example, if an additional $1,000 expenditure on a treatment facility yields additional benefits equal to only $750, the additional investment's cost is more than the benefits it provides, so it would be inefficient to expand the facility. However, suppose the municipality pays only $250 of an additional $1,000 investment, since its cost share is 25 percent. If it receives more than $250 in benefits from an additional $1,000 investment, it will be encouraged to expand the facility. Thus cost sharing can encourage a community to build too large a project from the standpoint of national costs and benefits.

Choice of the optimal scale for a waste treatment project, according to the study, can be encouraged by Marshall's "Association Rule." According to the Association Rule, municipalities will choose a scale of abatement that is both locally and nationally efficient if they pay a cost share equal to their share of marginal benefits. The authors feel that the Federal Government's 75 percent cost share is probably too high because it may encourage communities to build oversized facilities. "And yet you don't see municipalities breaking their necks to build sewage treatment plants," Ruegg noted. "We suggest that other factors may be limiting development."

Constraints on Development

One problem involves the distribution of benefits. Which benefits are widespread enough to be considered national in scope? Which can be considered local benefits which accrue to nonfederal interests? The authors feel that most abatement benefits probably accrue locally. However, munici-

To clean up the Nation's waterways, many sewage treatment plants must be expanded or new plants built. The NBS study makes recommendations on how this can be done in a manner that is both nationally and locally efficient. (Photos of waste treatment plants courtesy EPA-Documerica, top by John Neubauer, center by Belinda Rain)

palities which receive Federal funds and make investment decisions may see benefits accruing outside their relatively small jurisdictions as Federal benefits and consequently will not pay for them. Without effective regional cost-sharing management, it may be difficult to apportion costs appropriately between the nonfederal sector and the Federal Government.

Another constraint on pollution abatement is the use of "sewer politics" to check population growth. A county board of supervisors chairman summed up the problem saying, "We've used sewers as a growth management tool. It's a bad one, but it's the only one we've had."

User Fee Impacts

Finally, the authors examine user fees—the charges imposed on industry, households and businesses for use of sewage removal and treatment facilities. "The existing user fee arrangements change effective cost shares, and that's why we looked at them in this study," said Ruegg.

The authors show that the existing user fee program contributes to inefficiency both in the selection of techniques and in the sizing of facilities. The existing program also results in a larger Federal subsidy to industrialized communities than to residential communities.

Marshall and Ruegg conclude that under the optimal cost-sharing rules suggested in their study, communities would be encouraged to select more efficient abatement techniques and facility sizes. This improvement in efficiency would increase the degree of abatement per national dollar spent. □

Energy from Waste

THE "good life" in America is increasingly threatened by two enormous problems: waste and energy. Our ability to dispose of the first, find enough of the second and maintain a balance in our environment will greatly affect future living conditions.

A good solution to the waste and energy problems, according to National Bureau of Standards' physical chemist Dr. George Armstrong, would be one which solves them both. That solution would be to generate energy from wastes.

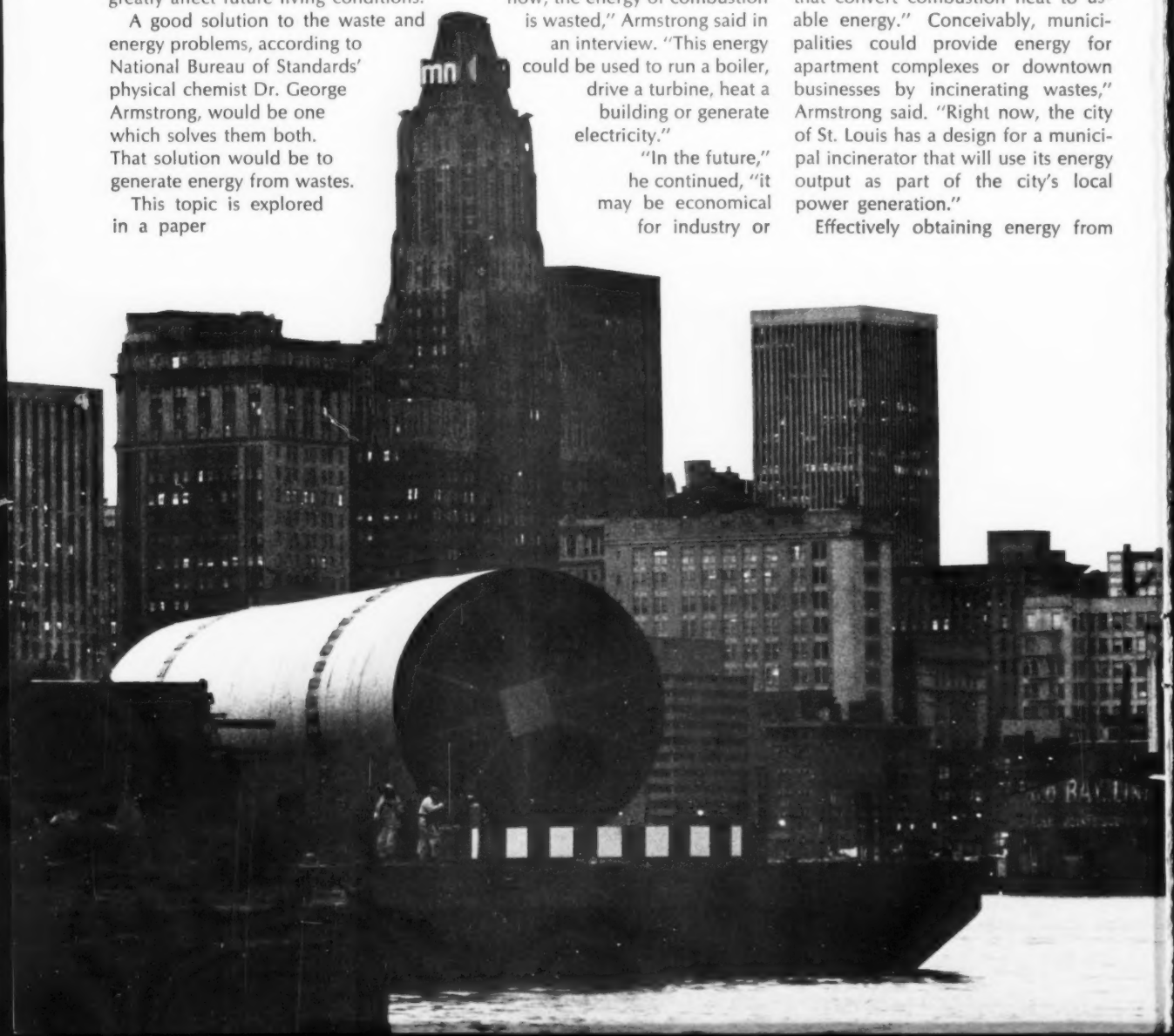
This topic is explored in a paper by Armstrong and NBS chemist Dr. Eugene Domalski, delivered by Armstrong recently at the Conference on Thermodynamics and National Energy Problems held in Warrenton, Va.

"When we burn wastes as we do now, the energy of combustion is wasted," Armstrong said in an interview. "This energy could be used to run a boiler, drive a turbine, heat a building or generate electricity."

"In the future," he continued, "it may be economical for industry or municipalities to provide some or all of their own power by burning their wastes."

Municipalities which have substantial waste disposal problems are likely to be attracted to incinerators that convert combustion heat to usable energy." Conceivably, municipalities could provide energy for apartment complexes or downtown businesses by incinerating wastes," Armstrong said. "Right now, the city of St. Louis has a design for a municipal incinerator that will use its energy output as part of the city's local power generation."

Effectively obtaining energy from



disposal of waste, according to Armstrong, can be aided by applying thermodynamic theory and data to practical problems like incinerator design.

Towards this end, Armstrong and Domalski have prepared thermodynamic tables for an incinerator designers' handbook recently published by the American Society of Mechanical Engineers (ASME). These tables indicate the heats of combustion of the organic materials which compose waste and the heats of formation for various metal oxides produced during waste combustion. The book, titled "Combustion Fundamentals for Waste Incineration," is available from ASME, 345 E. 47th Street, New York, N.Y.

An Imposing Problem

Americans generate over 3,600 million metric tons (1 metric ton = 2,200 pounds) of solid waste per year, or over 45 kilograms (1 kilogram = 2.2 pounds) per person each day. Presently, about 90 percent of all urban waste is disposed of in landfills, while the rest is burned in municipal incinerators.

However, many scientists expect the proportion of incinerated waste to increase in the future, due to the increasing difficulty of finding new landfill areas and to the high cost of transporting wastes to more remote landfills.

Of approximately 3,600 million metric tons of solid waste generated in America each year, urban waste accounts for about 360 million metric tons, mineral waste for about 1,500 million metric tons and agricultural waste for over 1,800 million metric tons. Dry organic solids, which can be burned to yield energy, account for under half of urban and agricultural wastes, and essentially none of the mineral wastes. An estimated 15 percent of the organic solid waste is collectable.

Although this percentage seems low, there is nonetheless potential for converting at least some of our waste into energy. Many elements of urban waste yield combustible energy close to or equal to that of coal or fuel oil. Coal's combustion energy is equal to 28 million to 33 million joules/kilogram (1 million joules/kilogram = 430 Btu/pound) while fuel oil's is 42 million joules/kilogram.

However, the newspaper we throw away, if dry, could generate energy equal to 20 million joules/kilogram. Waxed milk cartons, after drying, check in at 27 million; cooked meat scraps at 29 million; discarded heels and soles of shoes at 26 million; and tree leaves at 21 million. Most ingredients of urban waste are low in sulfur, a potential pollutant, according to Armstrong.

From Waste Pollution to Air Pollution?

When it comes to the environment, the solution to one problem often creates another. Remarking on Armstrong's ideas, one scientist recalled that "in 1904, New York City was saved from a horrible pollution problem when the horse was replaced by the automobile."

With large-scale waste incineration, careful measures to prevent air pollution will have to be taken. However, Armstrong does not think air pollution concerns will impede development of energy-transforming incinerators.

"The real pollution problem is garbage," he said. "If you don't dispose of it, you can't live."

"Incineration is a method of disposal which greatly reduces the volume of waste," he continued. "We have to use incineration, as we use it now, due to the increasing difficulty of finding landfill. The solution to the air pollution problem is part of the general incineration problem."

One way of purifying emissions from waste incineration is "scrubbing" or spraying the smoke with water. The sprayed water dissolves waste particles in the smoke before it reaches the air. However, the ensuing problem is how to dispose of the water after it is dirtied.

Jokingly, Armstrong offered a solution to the environmental runaround, saying, "Of course, we could do it like in ancient days, when they piled refuse in the streets, and every few

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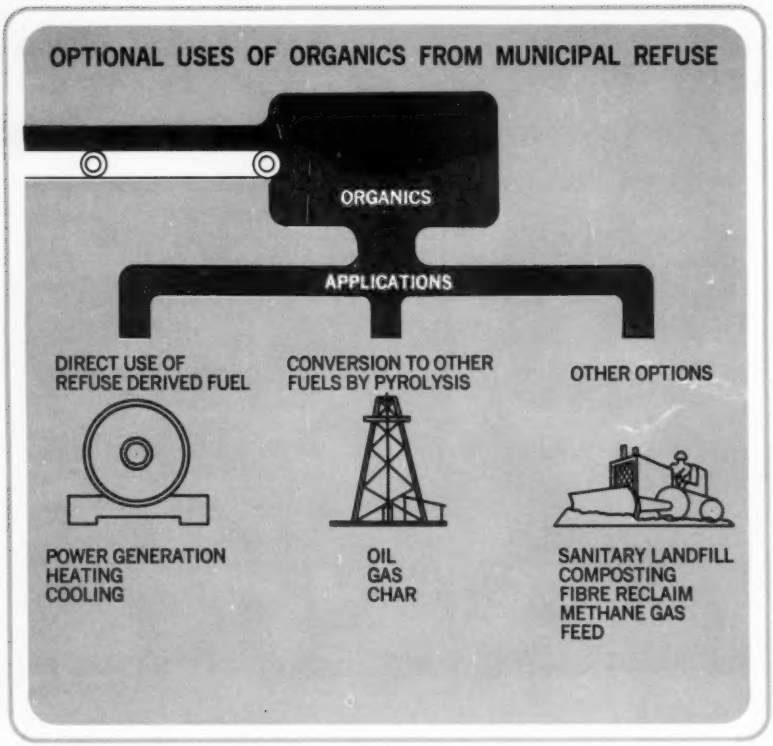
A giant rotary kiln that, when installed, will process solid waste into useful metals, steam for heating and roadbuilding materials. Inventive systems like this will help avoid such unsightly and polluting dumps as shown at right. (Left photo courtesy Monsanto Company, right courtesy U.S. Environmental Protection Agency.)



centuries built a new city on top of the rubble."

Where From Here?

Long before men piled refuse in their streets, Armstrong noted, they lived in equilibrium with nature. In nature's equilibrium the sun's energy is converted to chemical potential energy as cellulose and other organic substances. In earlier ages, man used wood and other organic fuels no faster than nature could regenerate them and created wastes no faster than they would naturally disappear.

With the industrial revolution however, man expanded his energy use tremendously. Fossil fuels, which are vast reserves of stored high potential chemical energy, came into use and were so freely available they have been used carelessly. Even with today's rising fuel prices, we hardly attempt to maximize fossil fuels' potential use.

With the phenomenal development and energy usage of the industrial era, we have accumulated vast quantities of waste, much of which is only partially used material. Only now are we beginning to realize that our natural resources cannot be exploited indefinitely.

While few of us would advocate a return to agrarian society, Armstrong advocates returning to a principle of agrarian life—using natural materials to their fullest potential. This can be done, he notes, with today's advanced technology.

"Rather than accomplishing our goals through ad hoc or empirical techniques," he writes, "we should apply the resources of molecular structure analysis, kinetics and thermodynamics to help us solve the problems of waste disposal and energy generation."

A major concern in this area, he notes, will be to present thermodynamic data in a form that can be understood and utilized by all people working in the field—for example, the technician helping to design or operate an energy-converting incinerator.

Further Suggestions

As an alternative to obtaining energy from waste incineration, there exist several techniques for making waste into oil. Armstrong says that converting all organic waste into oil, if it could be done, would fulfill the Nation's demand for residual fuel oil, which is used for home heating and diesel trucks.

In the hydrogenation process of waste conversion, 85-95 percent of the carbon present is converted to oil. After being "cooked" with other materials at a high temperature in the absence of oxygen, one ton of dry organic waste yields about two barrels of oil. Since it takes 0.75 barrel of oil to "cook" the waste, the net oil production is about 1.25 barrels per ton of waste. The resulting oil is low in sulfur and high in heating value—35 million joules/kilogram.

There is also a pyrolysis process which converts organic dry waste solids to oil. Years ago it was used to convert wood to oil and chemicals, but oil from pyrolysis was displaced by cheaper, more available petroleum.

Bioconversion of waste by anaerobic digestion by bacteria can produce about 280 cubic meters (1 cubic meter = 35 cubic feet) of methane gas per ton of solid waste. "Methane could be produced in big vats, like in a brewery," suggested Armstrong.

Finally, Armstrong notes that cellulose waste can be converted to gluclose, industrial waste to bricks and agricultural waste—specifically, manure—can even be converted to edible protein. Clearly, there are many alternatives to being overwhelmed by our own garbage, and the application of scientific theory to everyday problems will provide better solutions. □

Grain Alcohol Detected in Space

INTERSTELLAR ethanol—also called ethyl alcohol and popularly known as grain alcohol—has been detected in the direction of the center of our galaxy in an astronomical source known as Sagittarius B2. The discovery was made by three different research groups comprising scientists from six institutions—including the National Bureau of Standards.

Method of Deduction

Ethanol was found in Sagittarius B2 by means of the characteristic microwave radiations the molecules emit. Each molecule broadcasts, so to speak, on a number of well-defined frequencies (spectral lines), and the molecules are detected and identified by electronically sensing and measuring these frequencies with radiotelescopes and auxiliary electronic devices. The discovery of ethanol involved two particular frequencies produced by quantum transitions in which the molecules go from one level of rotational energy to another.

To make an identification, one needs to know—by direct laboratory observations or by calculations using quantum considerations and an analysis of the known portion of the spectrum of the molecule—what these frequencies are, the so-called "rest" frequencies. The molecules in space, however, are usually moving towards or away from the earth at appreciable velocities which, by the Doppler effect, changes the observed frequencies. Normally, the Doppler shift can be corrected for on the basis of past observations.

However, detecting radio signals from space is not quite as simple as tuning in a radio or TV station because the signals from the distant interstellar molecules are extremely weak and almost completely lost in a background of electrical noise. To extract the signal from the noise, each observation must usually extend over periods of many hours, and electronic techniques are used to average the signal over the observation period. The noise fluctuates randomly, and so tends to cancel out from the average, while the weak but steady signal from the molecule persists in the final average.

Sequence of Events

The events leading to the discovery of ethanol in Sagittarius B2 began with the October 1-3 observing session at the National Radio Astronomy (NRAO) 11-meter radiotelescope at Kitt Peak in Ariz., where Ben M. Zuckerman of the University of Maryland, Barry E. Turner of NRAO and Nick Fourikis of the Australian CSIRO (Commonwealth Scientific and Industrial Research Organization) detected an unidentified signal they thought might be a rotational emission signal from either ethanol or methoxyethyne. They favored assigning the signal to the $4_{14}—3_{03}$ transition of ethanol, but did not have a precise rest frequency available to them to make an unambiguous assignment.

During the very next observing session, October 4-6, Frank O. Clark and Donald R. Johnson of NBS used the same NRAO telescope to attempt to observe signals from still another new interstellar molecule. In the course of their observations a signal appeared at a frequency slightly different from that of the molecule under investigation. Based on precise rest frequencies calculated by Frank J. Lovas of NBS, the new signal was immediately assigned to the $6_{06}—5_{15}$ transition of trans-ethanol.

At this point, as required by protocol, the NBS team contacted Mark Gordon, assistant NRAO Director for Tucson operations, and requested permission to deviate from their original proposal in order to pursue the $4_{14}—3_{03}$ transition of trans-ethanol and thus confirm their detection. Gordon checked his files of proposals and discovered that the $6_{06}—5_{15}$ transition of ethanol had already been requested by another group and was therefore protected under NRAO's priority system. He requested that work on ethanol cease at this point until a decision could be made on how the interests of the group holding the priority could be protected.

In the meantime (a few hours later), Zuckerman contacted NRAO to discuss the unidentified line that their group had detected and thought might be due to ethanol. It then became obvious that the line of Zuckerman, Turner and Fourikis was at the very same frequency as the $4_{14}—3_{03}$ ethanol line the NBS team had requested permission to observe to confirm their detection.

It was subsequently learned that the priority proposal for the $6_{06}—5_{15}$ ethanol line had been submitted by a group from the Center for Astrophysics of Cambridge, Massachusetts.

In the lengthy discussions that followed it was decided to publish the results of the detection of ethanol as a joint report from the three observing groups involved. The final publication, to be published in the *Astrophysical Journal*, will have a total of 13 authors from six institutions. □

Screw Thread Standards—Who Needs Them?

SCREW threads are used in some 2 million different U.S. products.

Wherever technology exists, screw threads exist. Their pervasiveness means that people feel no need to think about them—screw threads are simply "there," more or less taken for granted. But industrial and developing nations around the world have found that they cannot afford to take screw threads for granted.

If a bolt made in the United States does not fit a nut shipped from country X or country Y, this failure of compatibility or interchangeability may have broad consequences, such as:

- International economic and trade dislocations.
- Supply and operating problems in the industrial and defense establishments of America and her allies.

For example, American factories in 1970 shipped some $2 billion worth of threaded fasteners to customers at home and abroad, and the installed value of these items was estimated at $10 billion. (Fasteners are only part of the picture, since other threaded components also go to make up the screw thread industry.) In addition, the U.S. Government annually purchases in excess of $100 million worth of threaded components, while the industry's $51 million annual export volume has a highly beneficial effect on the U.S. balance of payments.

Public safety is another area affected by screw threads. If, for example, a Philadelphia fire hose coupling does not fit a Baltimore hydrant, either city may be seriously handicapped in a large-scale emergency. This lesson was driven home by the great Baltimore fire of February 1904. In 2 days, 2,500 downtown buildings worth $50 million were gutted while engine companies from nine neighboring cities stood by helplessly because their hoses could not be coupled to each other and would not fit Baltimore hydrants.

It is more than a question of "fit." Quality control as well as compatibility and interchangeability is dependent upon national and international screw thread standardization. Screw thread standards figure in innumerable daily situations—as, for example, in the routine safe arrival of a commercial airliner, lowering its landing gear with benefit of traversing screws whose threads are standardized to withstand stress or fatigue. Experts estimate that there are 8 million threaded fasteners in a 747 aircraft and 2,000 of them in an average automobile.

These and other vital considerations have moved governments and technical groups to engage in screw-thread standards activity spanning the past six decades. It is not the kind of effort that can be expected to reach any final solution—constantly changing technology requires modernized standards to meet current needs. Significant advances, such as new metals and alloys with different properties from the old, make imperative the development of revised specifications or performance standards.

The pressures of World War I prompted the United States to take the first formal step toward coordinated national screw thread standards.

Congress in 1918 established a screw thread commission. It was instructed to work for compatibility and interchangeability of threaded fasteners and fittings. In addition, it was to improve communications between the War Department and the manufacturers who provided military hardware.

At war's end, it was soon realized that innovations in civilian as well as military technology required further development and monitoring of screw thread standards. The range of potential applications ran the gamut of 20th-century technology and hardware—from screws and bolts to light bulb bases, connectors for oil well drilling and pumping equipment and precise optical components.

Congress twice extended the life of the wartime screw thread commission in the 1920's to allow more time for implementing plans to "reduce the variety of screw threads in general use, facilitate manufacture in case of war, make the best use of labor in our industries in time of peace, increase the safety of travel by rail, steamship, and aeroplane, and in general . . . increase the dependability of all mechanisms." In the late 1930's a reconstituted interagency committee—now called the Interdepartmental Screw Thread Committee (ISTC)—began operations. With broadened representation of the Commerce and Defense departments and leading voluntary standards organizations, the ISTC initiated thousands of high-quality screw thread standards that were recognized and adopted by industrial standards groups in the United States and other countries.

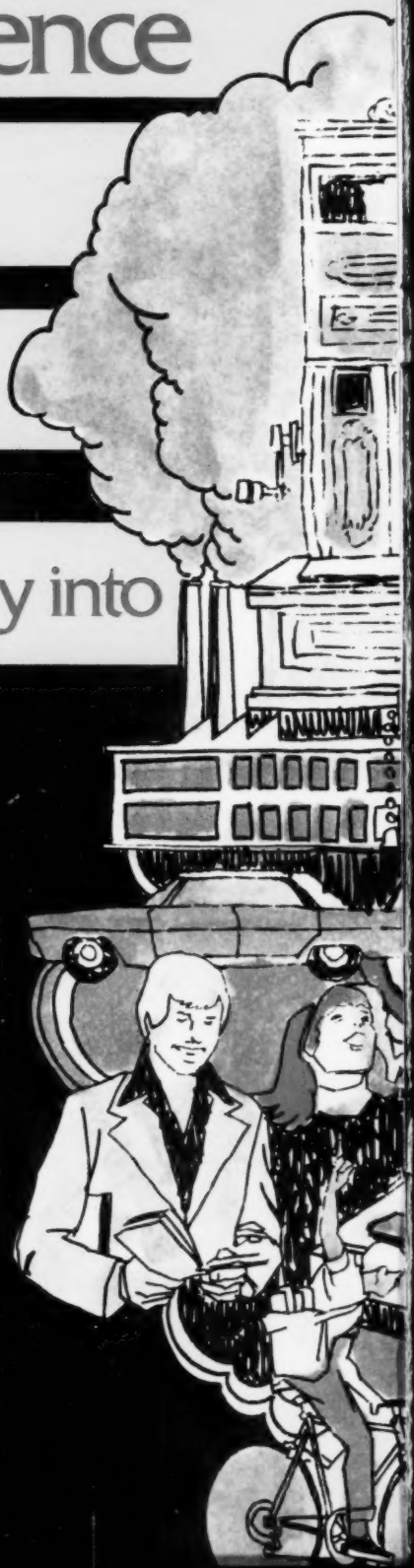
In 1948, after 30 years of effort, the first comprehensive agreement on unification of the screw thread standards of Great Britain, Canada and the United States was signed at the National Bureau of Standards in Washington. The tripartite accord emphasized "basic requirements for general interchangeability of threaded products" and stated that the signatory organizations "will maintain continuous cooperation in the further development and extension of these standards." The 1948 agreement emerged after World War II experience demonstrated a large handicap because of insufficient standards. Screw threads produced in the three countries throughout the war were not interchangeable, resulting in severe inconvenience and great economic loss.

Like the 1948 treaty signers, today's European Common Market and other leading intergovernmental bodies display a vital interest in questions of screw thread standards, compatibility and quality control. Metric screw thread standards are a leading topic in today's interactions among spokesmen from all industrial nations.

ISTC government participants now include representatives of the Atomic Energy Commission, the General Services Administration, the National Aeronautics and Space Administration and the Federal Aviation Agency as well as Defense (Army, Navy and Air Force) and Commerce Department (National Bureau of Standards) agencies. Also working with the ISTC are the American National Standards Institute, trade associations and various technical societies. □

Measurement Science in Transition

From the Laboratory into



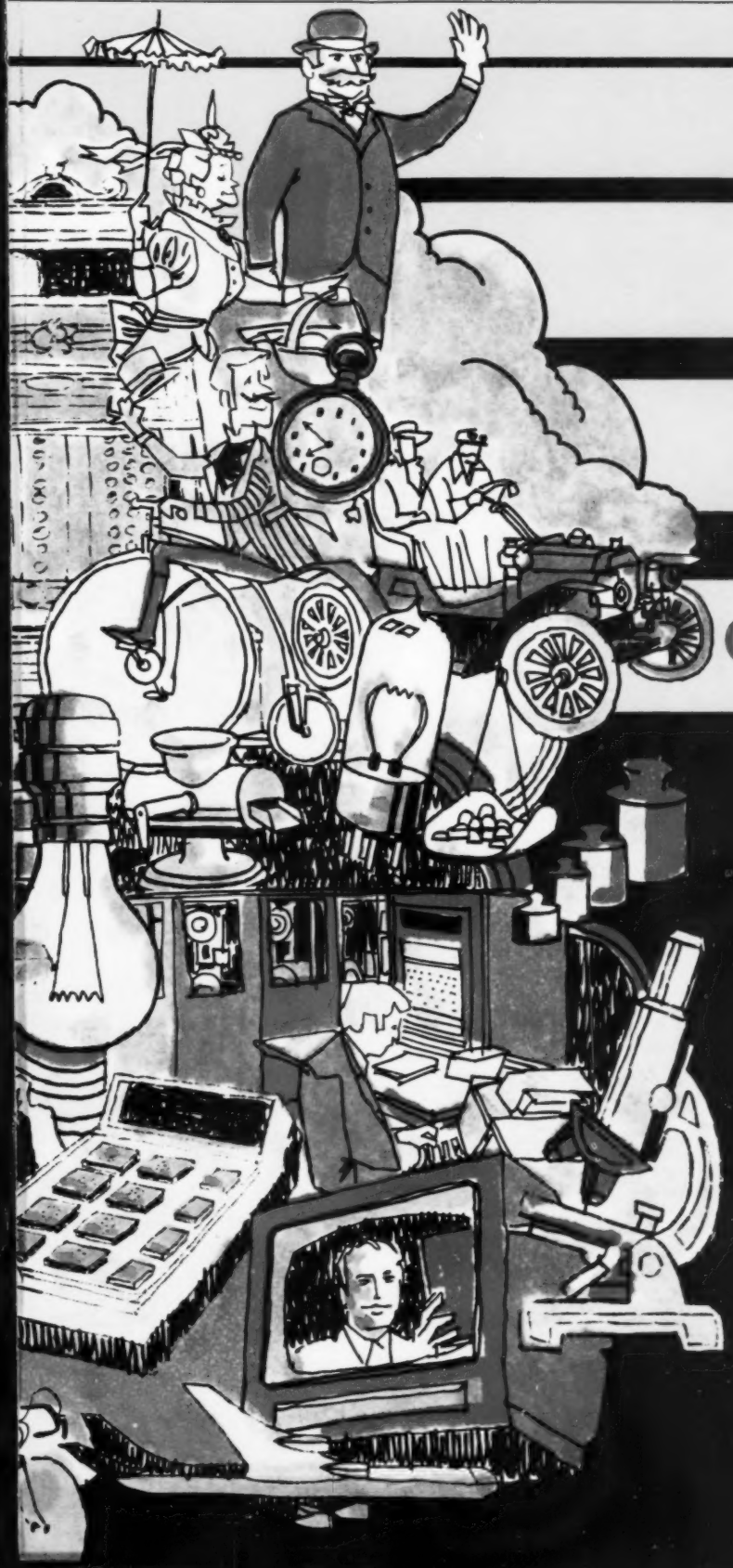
Excerpted from a speech given by Dr. Ernest Ambler, Deputy Director of the National Bureau of Standards, at the Joint Measurement Conference held November 12-14, 1974.

The continuing efforts of many people and organizations have provided the Nation with a generally excellent measurement base. Highly accurate measurement standards are available for many basic quantities, and calibration services extend this accuracy to many levels. However, we now need to concentrate on the extension of measurement competence from laboratory to "end use."

It is clear to us all that over the last several years, there has been an increasing national concern with the need to protect workers from hazards, to give consumers safe products and information to enable them to make choices based on a variety of considerations such as the energy efficiency of products. We have witnessed concern over the international effectiveness of our standards-writing procedures, particularly with regard to their potential use—to the disadvantage of the United States—as non-tariff trade barriers. And, as we have tried to improve and extend medical care, we have seen the application of automation to medical diagnoses and a concomitant need to introduce new ways to assure quality control of measurement procedures.

We see all around us a growing need for practical measurements. We know the proliferation of Federal laws and regulations demand this, that State and local codes and laws are a part of it and, indeed, the concerns of industry with safety add to the need for more uniform measurements to be used in definite functional programs.

As an example of the complexities and multiplicities of concern that often arise in various programs, I would like to deal with the problem of noise control. The point is that rules and regulations generate measurement needs that have to be carried out in the field, often under



Our Daily Lives

adverse conditions. The Federal Aviation Agency, the Environmental Protection Agency, the Occupational Safety and Health Administration, the Department of Housing and Urban Development as well as State and local government agencies all have regulations and laws dealing with noise. Their areas of concern are often different but, generally speaking, the measurement base is the same. Specifically, OSHA rules limit worker exposure. To meet these criteria is a fairly complex matter because it means the worker has to be monitored for the daily dose of noise that he receives. In addition, those workers that are employed in noisy environments require annual audiometric tests to determine whether there has been any loss of hearing.

EPA has also established noise rules to protect the general public. It has published rules that require new trucks to meet noise specifications with a decreasing noise level

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allowed over several years. In addition, EPA is formulating rules to limit the noise of air compressors—the noisiest type of construction equipment after trucks.

HUD is withholding construction loans if neighborhood noise levels exceed certain limits. On the face of it, the definition of neighborhood noise seems clear. However, it is not at all clear where instruments should be placed so readings can be taken to determine compliance or noncompliance with regulations.

In addition to these and other Federal rules, many states have noise regulations for a variety of motor products: snowmobiles, motorcycles, trucks and cars. And, if that weren't enough, there are also building codes —in New York City, for example— that limit the amount of noise that can be transmitted through floors in apartment buildings.

I have tried to illustrate here the diversity of concern in only one area: noise. But I could do the same thing in a number of areas, including air pollution, water pollution, radiation control of all types and medical measurements.

Amid this complexity where do we stand today? In particular, where do we stand with regard to similar measurement needs for different objectives? I think in some ways we are in good shape, particularly in the area of basic measurement expertise. In other ways, I feel we need to improve procedures for making multiple use of measurement practices and know-how. Here at NBS, to go back to first principles, the Bureau has a unique role in assuring the availability of measurement competence and control. We know, also, that great measurement competence exists in industry and indeed the necessary instrumentation will be developed there if sufficient market opportunities exist. And market opportunities do exist—for example, there is a need for a reliable personnel noise dosimeter to determine a worker's daily exposure to noise.

It is clear also that the devices needed today are field devices, which must be rugged, reliable and simple to operate since they will be used by a large number of people in a variety of circumstances.

In spite of our desire to help solve many of these emerging measurement problems, there are many cases where NBS is capable of rendering assistance but doesn't do so because the institutional arrangements necessary for cooperative efforts don't exist. In our concept of the case, better coordination is required among State and local governments, industry and the Federal Government in the application of measurements.

Now this is not a new idea. Many such examples do exist. The National Conference of Weights and Measures has been and remains an effective organization in the enforcement of a fair market place, particularly with respect to retail transactions. The National Conference of Standards Laboratories is an effective organization for assuring traceability of precision measurements, especially as they relate to defense and aerospace needs. And the National Conference of States on Building Codes and Standards is performing an invaluable service in trying to bring about coordination among States' codes and standards for buildings. All of these, from our vantage point at NBS, are examples of the kinds of arrangements that can bring numerous sectors together for a common purpose. And we believe that similar arrangements are necessary to cover the broad array of problems that I mentioned.

However, before we can think in terms of coordination on the national level, there must be coordination at local and State levels. Presently, there is no mechanism within a state to identify problems, to set priorities or to communicate its measurement needs systematically. State measurement services can be found in many different agencies. In the State of California, for example, there are at least seven different agencies where physical measurements play an important role. In an attempt to remedy this situation, a metrology advisory committee was formed. Under this measurement-oriented committee, several agencies within the State, working together, have taken on the responsibility of trying to define the key measurement needs within the State of California and then communicating these to NBS.

In any new institutional arrangement, it is clear that there will be a role for industry and for the Federal, State and local governments. Industry must provide the expertise for building the instruments and equipment to make the measurements. These new instruments and services are necessary for State and Federal agencies to carry out, in a fair and equitable way, the enforcement of regulations. Such partnerships will bring the necessary expertise to bear in tackling the demanding measurement problems that are emerging today. □

HIGHLIGHTS

Forensic Science Aid

NBS has issued a Standard Reference Material (SRM) of borosilicate glass, the type of glass used in auto headlights, as an aid to forensic science laboratories in identifying glass fragments found at the scene of a crime. This standard will also fulfill needs of food, glass, paint, plastic, pharmaceutical, chemical and optical industries where refractometers are used to determine product purity and quality in process control.

SRM 1820, Refractive Index Glass, is designed for both calibrating refractometers and certifying refractive index immersion liquids. For information, write the Office of Standard Reference Materials, B311 Chemistry Building, NBS, Washington, D.C. 20234.

Nuclear Safeguard

Under the sponsorship of the Arms Control and Disarmament Agency, NBS has developed a special tamper-resistant surveillance camera for nuclear safeguard systems. The camera is presently undergoing field evaluation tests at several uranium enrichment facilities.

Computer Weather Data

NBS will assist the National Weather Service (NWS) in setting up a computer network for the collection and dissemination of weather data. Specifically, NBS will study the reliability of the network and its planned back-up facilities, as well as the proposed error control provisions. In addition, the Bureau will provide information to guide NWS in the procurement of the necessary components to assure successful operation of the computer-communications network even under adverse weather conditions.

Highway Safety

To counter one of the most treacherous hazards of driving, NBS has undertaken research for the Federal Highway Administration to determine the best way to make highway lane markers visible on rainy nights. The study will involve the evaluation of various classes of sensors for detecting approaching traffic. Piezoelectric polymer transducers and directional microphones will be tested as transducers for converting the vibration or sound of approaching traffic into signals to trigger the illumination of electrical lane markers.

Neutron Radiography

NBS and the American Society for Testing and Materials will cosponsor a symposium on "Practical Applications of Neutron Radiography and Gauging" at the NBS Gaithersburg, Md., laboratories on February 10 and 11, 1975. Applications of neutron radiography and gauging in the areas of nondestructive testing, nuclear applications, explosives, aerospace and medicine will be discussed.

For information, write Harold Berger, A106 Reactor Building, NBS, Washington, D.C. 20234.

Weathering Factors

A report recently issued by NBS identifies the types of climatological and weather data available and describes how this information can be used to design durability tests for building components and materials. These durability tests are used to predict the long-term performance of building materials and components under actual conditions.

Titled "The Use of Weather and Climatological Data in Evaluating the Durability of Building Components and Materials," the report is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402, for $1.45. Order by SD Catalog No. C13.46:838.

Sub-Doppler Spectra

NBS scientists at the Joint Institute for Laboratory Astrophysics recently observed sub-Doppler spectra from a high-velocity atomic beam using saturation-spectroscopy techniques. In their approach, an atomic neon beam intersects an optical standing wave produced by a continuous-wave, frequency stabilized dye laser. Tuning the laser through a neon resonance produces an absorption line with a nonlinear feature that is unaffected by first-order Doppler shifts or broadening.

This new application is being developed as part of an experimental program to measure the relativistic transverse Doppler shift with high precision. The method may also be useful in the measurement of certain fundamental physical constants. □

Reduction of Earthquake Losses Sought

SIGNIFICANT reduction in the death and damage potential of future earthquakes is the goal of a government research project slated for April 1976 completion.

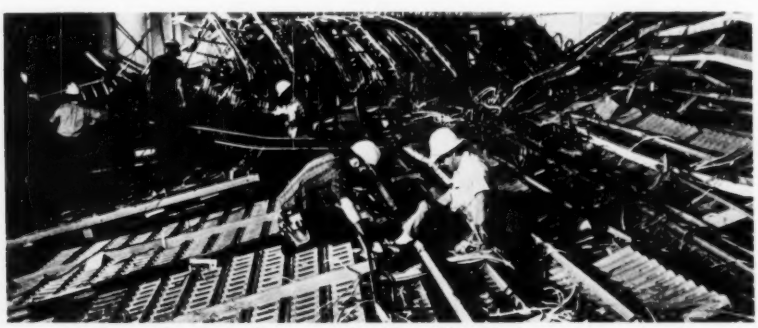
A contract signed by the Applied Technology Council (ATC) and the National Bureau of Standards blueprints a two-phase, 20-month project. Researchers in the project will pit building design expertise against seismic calamities that to date have killed more than 1,500 Americans and caused over $1.8 billion in property losses.

The ATC, a non-profit organization established by the Structural Engineers Association of California, represents 2,000 members and is serving as a liaison with associations in many states, including Washington, Oregon, Nevada, Utah, Hawaii and Illinois.

Funded by a total of $895,000 from the National Science Foundation under its Research Applied to National Needs (RANN) program, the research project calls for development of comprehensive seismic design provisions for buildings. On the basis of an ATC plan covering the project's scope, organization and methodology, the specialists will update, expand and substantially revise current seismic provisions in the light of recent research results.

Coordinated by the NBS Center for Building Technology (CBT), project findings will include an assessment of the level of risk associated with various seismic design provisions for the guidance of regulatory bodies. The scope will encompass all aspects of building and geotechnical practices to mitigate disastrous earthquake effects. Among basic questions covered will be:

- Provisions for architectural, mechanical and electrical features of construction.
- Considerations of seismicity, geological and soil-site effects.
- Soil-structure interaction.
- In-depth analysis and codification of required loading and performance criteria.
- Investigation of design procedures for structures not presently included in the seismic building provisions.



Prevention or mitigation of community-disrupting damage like this is leading goal of a cooperative project aimed at developing comprehensive seismic design provisions.

Project administrators point out that U.S. population growth and increasing urbanization have resulted in concentrations of structures built in earthquake-prone areas. Some experts today suggest, for example, that if the series of large 1811-12 earthquakes at New Madrid, Missouri, were to occur today, losses could total well over $50 billion and countless lives—instead of the single death and minor property damage actually sustained at the time of the event when population was sparse. □

Test Patterns For Integrated Circuits

TEST patterns for integrated circuits, little talked about but widely used, were the topic of a workshop held this fall in Scottsdale, Ariz. Seventy-six engineers and scientists from the semiconductor industry and the Federal Government participated in the workshop, which was sponsored by the National Bureau of Standards and the Defense Advanced Research Projects Agency (ARPA).

The purpose of the workshop was to promote an interchange among various industrial and government organizations leading to a better understanding of the present and future usage of test patterns. The workshop showed that the semiconductor in-

dustry routinely uses test patterns for a variety of purposes, ranging from checking mask alignment to assuring product quality. However, the workshop also showed that the large volume of data generated from these test patterns and the requirement for rapid diagnostic feedback presents a severe data management challenge which makes automatic data acquisition and display systems indispensable.

The workshop expanded on the material of the Mini-Symposium on Semiconductor Test Patterns conducted by the ASTM Committee F-1 on Electronics in January, 1974. Present ASTM efforts in test patterns include the creation of a task force, headed by Martin Buehler of NBS, to evaluate various test pattern structures useful for radiation hardness and quality assurance, and to recommend standard test structures for manufacturers and their customers. Sheet resistance test pattern structures will be the first to be considered.

The NBS work on test patterns is part of an ARPA-sponsored activity. It is a major element of an NBS program that seeks to develop, and to disseminate to the electronics community carefully evaluated and well documented test procedures and associate technology to solve measurement and standardization problems in connection with the manufacture, procurement and application of semiconductor devices.

A workshop report is to be published. Additional information about the report and about the ARPA/NBS program may be obtained by writing Harry A. Schafft, Bldg. 225, Room A327, NBS, Washington, D.C. 20234. □

NBS Developing Guidelines for Computer Vote Counting

ONE out of every 10 votes cast by Americans in November's general elections was counted by a computer device. In the future, computers will be used increasingly to count votes faster and more efficiently and accurately than people can do by hand.

Because of this trend, the National Bureau of Standards has been asked by the Clearinghouse on Election Administration to develop guidelines for reliable use of computers in vote tallying.

Proposed guidelines should be delivered to the Clearinghouse by next spring. The Clearinghouse, which will soon move from the General Accounting Office to the new Federal Elections Commission, will have the responsibility for making the guidelines available to State and local elections officials.

The use of computers to count votes in elections has not automatically insured progress. Breakdowns have occurred in which the computer yielded suspicious results until the election board gave up in frustration and hand-counted the computer card ballots.

"Let's not make the computer the scapegoat for human error," says Dr. Ruth M. Davis, Director of NBS' Institute for Computer Sciences and Technology.

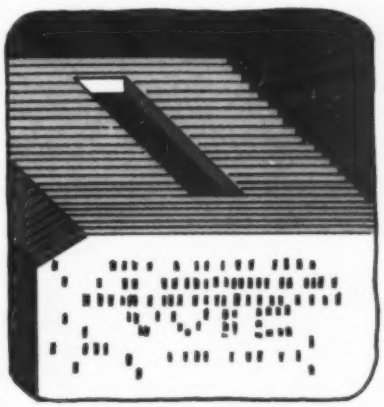
"Computers are our unwitting servants that need to be planned for, tested and supervised in order to serve us properly. Knowledgeable management of computer technology is requisite whether the computer is handling a payroll, synchronizing the take-offs and landings at an airport, or counting votes in an election," she adds.

"Our guidelines will recommend steps which can be taken by election administrators to insure proper functioning of the computer equipment and accurate computations," Dr. Davis says.

Roy G. Saltman, manager of the project at NBS, has examined all types of computerized voting systems. He has also talked with numerous State and local elections officials including those in Michigan, Oregon, Los Angeles County, California and the District of Columbia.

In most computerized systems today, Saltman explains, the voter designates his choices by either punching holes or making machine-readable marks on a special ballot. The voter drops the ballot in a sealed ballot box. These ballots are collected after polls close and are fed through a reader that scans the ballots.

The computer takes this data, totals it and prints out the results for each candidate and issue. Many jurisdictions find it more economical to use a local computer than to invest in the lever voting machines now used by a majority of voters. □



Cryogenic Data Compiled by NBS

THE National Bureau of Standards has published two monographs which are the most complete compilations to date of polymer properties and thermal conductivities of solids at low temperatures.

These milestone volumes are:

- NBS Monograph 131, *Thermal Conductivity of Solids at Room Temperature and Below*, A Review and Compilation of the Literature, Gregg E. Childs, Lewis J. Ericks and Robert L. Powell, 624 pages (Sept. 1973), $7.80, domestic postpaid.
- NBS Monograph 132, *A Compilation and Evaluation of Mechanical, Thermal and Electrical Properties of Selected Polymers*, R. E. Schramm, A. F. Clark and R. P. Reed, 848 pages (Sept. 1973), $10.25, domestic postpaid.

Previously this information was obtainable only by searching technical journals, conference proceedings, and industrial publications and reports. The new NBS monographs eliminate this wearying, frustrating and sometimes fruitless rummaging.

The books may be ordered from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Monograph 131 has SD Catalog No. C13.44:131; Monograph 132, SD Catalog No. C13.44:132.

Monograph 131, the successor to a 1954 NBS circular, again covers the literature from 1900 to 1954 as the earlier publication did, but with additional references on dielectrics and nonmetals, and it extends the coverage to mid-1971. Thermal conductivities are given for elements, alloys and commercial metals, semiconductors, semimetals, ionic and valence crystals, minerals, molecular crystals, polymers, glasses and disordered dielectrics. Conductivities at temperatures below 1 kelvin are in a separate section.

The tables and graphs that present the data are preceded by discussions of methods for measuring thermal conductivities, as well as the physical phenomena on which these methods are based.

Twenty pages of references document all data. In the tables and graphs a code ties each entry to its reference, and table entries also indicate the measurement method and the physical phenomena employed.

Monograph 132 exhaustively describes six polymers: polytetrafluoroethylene (and its copolymer with hexafluoroethylene); polychlorotrifluoroethylene; polyethylene terephthalate; polypyromellitimide; polyparaxylylene; and polycarbonate. These are representative of the most commonly used structural and film polymers at low temperatures.

Virtually all the bulk mechanical, thermal and electrical properties are compiled, plus others employed in applications design. Though temperature is the primary variable, other parameters (e.g., frequency and radiation dosage) are given where useful and available.

Before presenting its data, Monograph 132 defines and discusses all the compiled properties. The data are then given graphically, and for each polymer are grouped into three sections (mechanical, thermal, electrical). The references with each section are also indicated on the graphs.

The 20 mechanical properties include stress-strain curves; tensile, compressive, shear and flexural strengths and moduli; fatigue; creep; and hardness. Thermal properties given are expansion, diffusivity, specific heat and conductivity. The electrical properties are dielectric loss tangent, dielectric constant, volume resistivity and dielectric strength. □

NBS Circulates Recommended Standard for School Paste

A recommended voluntary standard for paste used in art education in schools is now being circulated to producers, distributors and users of this product for review. The standard is being processed by the National Bureau of Standards under the Voluntary Product Standards procedures of the U.S. Department of Commerce.

The purpose of this standard is to establish nationally recognized requirements for materials, preservatives, toxicity, discoloration of paper, adhesive strength, consistency, appearance and working qualities, containers and package quantities for school paste.

Voluntary standards for art materials have been in existence since 1946. The chalk sections of Commercial Standard CS 130-60 were revised in 1970 and the paints and inks

sections are currently being revised. This is the first time a standard has been issued for paste.

Copies of the recommended voluntary standard, titled "School Paste" and designated TS 173b, are available without charge from the Office of Engineering Standards Services, National Bureau of Standards, Washington, D.C. 20234. □

Three Studies of Smoke and Gas Fatalities Funded

THE vast majority of building fire fatalities are caused by smoke and combustion gases rather than burns. Studies aimed at reducing these fatalities are being funded by three grants totaling $328,000 from the National Bureau of Standards.

The grants have been awarded by the NBS Programmatic Center for Fire Research to Johns Hopkins University and the universities of Pittsburgh and Utah. They are:

- $116,000 to Johns Hopkins University for a study by its Applied Physics Laboratory (APL) to obtain reliable, in-depth information on the detailed causes of death of fire victims, particularly those due to "smoke inhalation."
- $137,000 to the University of Pittsburgh for research on the evaluation of toxicological effects of smoke and vapors from a variety of burning plastics.
- $75,000 to the University of Utah for evaluation of the smoke hazards of fire-retardant plastics commonly used in buildings and furnishings.

When combined, information from the three university research projects is expected to yield greater understanding of combustion product hazards. Recent studies indicate that it is this peril, rather than the direct effects of heat, which is responsible for up to 90 percent of building fire fatalities.

In cooperation with the State Board of Medical Examiners and Deputy Medical Examiners of Maryland and the District of Columbia, the Hopkins team will assemble data obtained from pathological, microscopic and toxicological investigations of an estimated 120 fire victims. These data will be coupled with pertinent fire-related information concerning fire causes, fire spread and materials involved to attempt to relate the nature of the burning materials to the detailed cause of death.

APL's program dealing with human pathology will be complemented by chemical analysis and controlled testing conducted at the University of Pittsburgh and the University of Utah.

Researchers at the University of Pittsburgh, under the direction of Dr. Yves Alarie, will determine the relative hazard of plastics by comparing the sensory irritation of laboratory rats exposed to the combustion products. In contrast to previous toxicology tests which have used the death of the animals as the sole measure of the hazard, the study at Pittsburgh will measure the rats' responses to low-level, sub-acute doses of smoke.

Concurrently, the University of Utah will evaluate the toxicological effects of combustion products from fire-retarded plastics. Headed by Professor I. N. Einhorn, the Utah team will screen plastic materials which are commonly used in buildings and furnishings. In contrast to the Pittsburgh project, they will observe general behavior and specific acute toxic effects on laboratory rats such as respiratory distress, unconsciousness, convulsions and death.

These research efforts reflect the increasing roles of smoke as a recognized fire hazard and of plastics as a major source of that hazard. Scientific observation of the effects of smoke and toxic gases will provide a basis for ranking materials according to the hazard they present. □

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Publications listed here may be purchased at the listed price from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (foreign add 25%). Microfiche copies are available from the National Technical Information Service, Springfield, Va. 22151. For more complete periodic listings of all scientific papers and articles produced by NBS staff, write: Editor, Publications Newsletter, Administration Building, National Bureau of Standards, Washington, D.C. 20234.